Design of Adaptive Vibration Control Systems with Application of Magneto-Rheological Dampers

by

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The design of nonlinear adaptive control systems for reducing vibration transmission in applications such as transportation systems is discussed. The systems studied include suspension systems, such as those used in vehicles, employing nonlinear magneto-rheological (MR) dampers that are controlled to provide improved vibration isolation. Magneto-rheological dampers use a novel class of smart fluid whose apparent viscosity changes as it is exposed to a magnetic field. The developed adaptive control scheme is designed to deal with the nonlinearities and uncertainties that commonly arise in most suspension applications. Some of the nonlinearities that are considered include time-varying characteristics, displacement-dependent effects, and hysterisis damping of magneto-rheological dampers. The uncertainties include mass and stiffness variations that can commonly occur in a suspension system. A number of nonlinear analytical models are developed and used in numerical simulation to evaluate the validity and effectiveness of the developed adaptive controllers. Further, the results of the numerical study are used in an experimental evaluation of the controllers on a seat suspension for heavy vehicles. The analytical and experimental evaluation both indicate the effectiveness of the proposed adaptive control technique in controlling vibration transmission in the presence of both system nonlinearities and uncertainties. The manuscript will provide a detail account of the modeling, dynamic analysis, adaptive control development, and testing that was performed throughout this study.

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